Pediatric pulmonary disease and related translational research involving EM and state-of-the-art technologies

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Abstract

The children's interstitial lung disease (ChILD) classification encompasses virtually all lung disorders encountered by pediatric pathologists in clinical practice. Within this spectrum, ultrastructural evaluation is most frequently applied to disease groups such as surfactant deficiency syndromes and pulmonary interstitial glycogenosis.

In the first part of this talk, we will explore the concurrent histologic and ultrastructural changes seen in these disorders and highlight relevant differential diagnoses. Electron microscopy (EM) combined with energy-dispersive X-ray spectroscopy (EDS) has emerged as a valuable tool for identifying causative agents in pediatric and adolescent inhalation injury cases. A series of such cases will be reviewed, along with a discussion of the research potential of EM-EDS applications in advancing pediatric lung health.

Human lung tissue has become increasingly precious, as the number of biopsies has declined due to advances in imaging techniques and the emergence of molecular diagnostics. Today, lung biopsies are primarily reserved for patients who fail to respond to advanced therapies or when clinicians suspect rare, often lethal neonatal lung disorders.

One example of the latter is alveolar capillary dysplasia with misalignment of pulmonary veins (ACD/MPV). Infants with ACD/MPV are typically born at term and present within days of birth with severe respiratory failure that rapidly progresses to therapy-resistant pulmonary hypertension, often resulting in early death. Histologically, ACD/MPV is characterized by diffuse acinar maldevelopment and marked vascular dysmorphism.

In the second part of the talk, we will present findings from studies utilizing state-of-the-art technologies—including synchrotron-based 3D image reconstruction, GeoMx spatial transcriptomics, and Polaris single-cell mapping—to redefine the pathobiology of this devastating disease.